THE HEATING AND VENTILATING MAGAZINE

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A TEST OF HOT BLAST HEATING COILS

The rapid increase in the number of hot blast heating plants installed in recent years and the lack of data showing the performance of such systems has led to an investigation of the subject, the results of which are here presented.

The tests were made at the Iowa State College by Messrs. L. S. Poage and D. C. Thomas, under the direction of Prof. G. W. Bissell and were reported by the *Iowa Engineer*.

The essential features of the apparatus are shown by the accompanying figures.

The air blast was obtained from a 55-inch Sturtevant exhaust fan driven by a 20 H. P. Corliss engine. The engine and fan were located on the ground floor and the air was piped to the floor above where it entered the heating duct as shown in Fig. 1. The inlet pipe connected with an expanding approach to the heater, en-

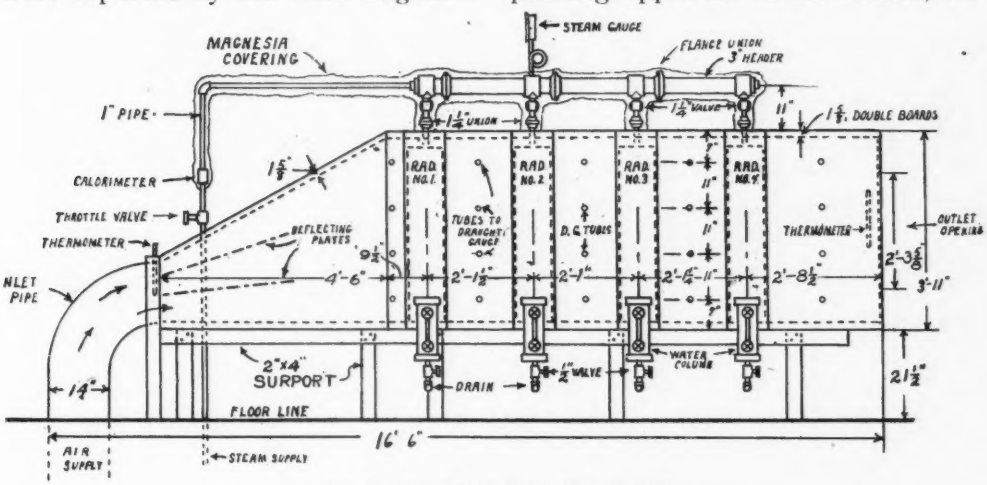
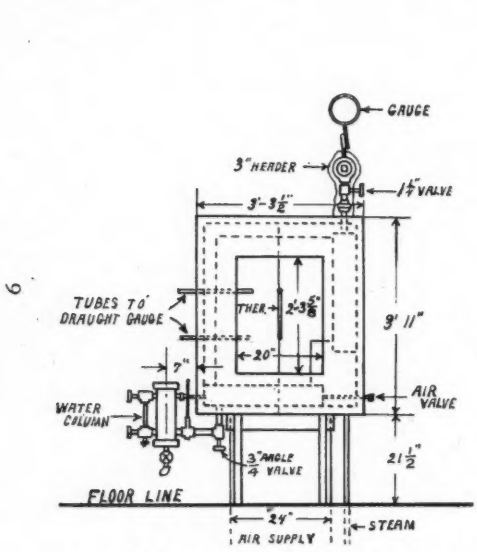


FIG. 1—SIDE ELEVATION OF HEATER
Inlet 14"x24". Outlet 20"x27⅝". Scale ½ in.–1 ft.

The object of experiments on hot blast apparatus should be to determine the arrangement, number and size of the various parts and the condition of operation to give the greatest economy in fuel and in fixed charges. In the work covered by the following tests attention was given only to the action of the heater coils as affected by changes in the steam pressure, air velocity and number of rows of pipe used.

larging from 14x24 inches to 36¼x43¾ inches—the full size of the main duct—in a distance of 4 ft., 6 in. Within this approach two plane metal deflectors were placed as shown in the diagram and adjusted by trial so that the velocity of air over the full charge area was nearly equal at all levels. A single heater section was first placed in front of the opening and in front of this a discharge end was fixed which had a rectangular

opening of 20x27⅜ inches as shown in the end view in Fig. 2. For the approach, duct and discharge end a double thickness of dressed and matched lumber with building paper between was used, but the frame surrounding the heater section was solid and 1⅝ in. in thickness. The joints between the various parts were made air tight by battening on the outside with building paper and wooden strips. As the sections were added the discharge end was moved forward and a short section added to the duct between the sections. The whole was supported as shown on a wooden framework rising 21½ inches above the floor.



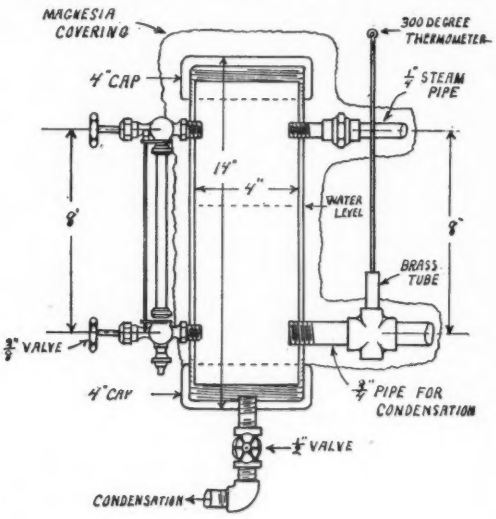


FIG. 2—END VIEW OF HEATER—Scale -- ½ in.=1 ft. Detail of WATER COLUMN—Scale....3 in.=1 ft.

The heater sections tested were of the mitre type shown in Fig. 3, with dimensions as there given. This type was used in order that the flow of condensation should be in the direction of the motion of the steam and that the condensation might at once be separated from the steam and drawn off for weighing.

The steam was taken from the college power plant main through a 1-inch pipe and to insure dry steam the pipe was drained to a trap from a fitting immediately below the floor line. By referring again to Figs. 1 and 2 it will be seen that, after passing through a valve where it was reduced from a pressure of approximately 100 lbs. to that desired, the steam reached the calorimeter and passed on through the 1-inch pipe for a distance of about six feet when it emptied into a 3-inch header to which the steam gauge and sections were connected.

The sections were connected with unions and valves in order that any one might be removed or cut out as desired. A throttling calorimeter was used. The exposed pipe, header and calorimeter were well lagged with plastic magnesia covering, approximately one inch thick.

Air was removed from the lower header of each section by a pipe and air valve as shown in the end view.

For removing the condensation a drained water column as detailed in Fig. 2 was used. It was found that a steam trap would not deliver the water with a sufficiently uniform flow to allow an accurate measurement of the quantity passing in any given time, while with the apparatus here shown this could be regulated very closely by observing the height of water in the gauge glass and opening the drain valve as required. From the water column drain the condensation was passed into buckets which had previously been partially filled with weighed amounts of cold water.

The air pressures were measured

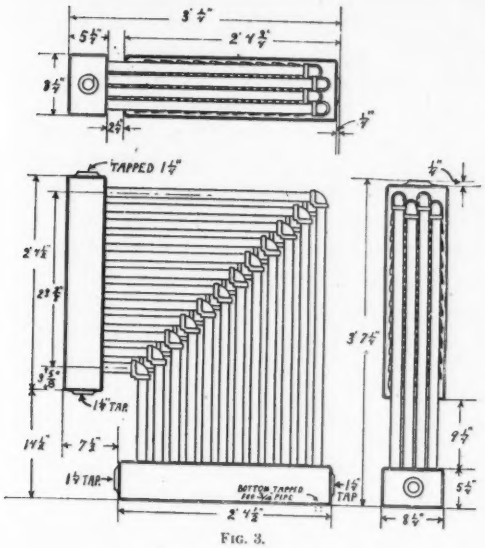


FIG. 3.

RADIATOR SECTION

Headers and Ells, Cast Iron. Pipe, 1 in. Black, Unpainted.

Spacing, 2⅜ in. cen. Staggered. Exposed Surface 62.5 sq. ft.

by means of a special draught gauge connected by rubber tubing to ¼ in. iron pipes with carefully squared ends which projected into the interior of the heater duct as shown in the general views. The apparatus illustrated in Fig. 4 was the result of an extended series of experiments made in the attempt to secure a satisfactory multiplying draught gauge and was found to meet all requirements as to accuracy, quickness of operation and delicacy of measurement. It consists, as shown, of a tank of water in which a weighed float is suspended from a spring balance and under which float the compressed air is introduced through the curved inlet tube. By sufficiently weighing the float the scale pointer was made to revolve nearly around the dial and its point of rest taken as the gauge zero. The instrument was then calibrated and a dial prepared from the calibration to read directly in inches of water pressure. It was found that 0.001 of an inch could be accurately read.

To find the position of average air pressure at each cross section a series of twelve readings were taken —one near each side and one in the center at the four heights shown in drawing. When the position was found the iron pipe was fixed in place and the unused holes in the duct closed.

In runs 1/14 only one radiator was used, in 15/29 two, in 30/35 three, in 36/41 four and in 42 and 43 steam was admitted into but one radiator while all four were left in the duct.

In the first and second series steam pressures of 5, 10, 15, 20 and 25 pounds were used. In the third and fourth only 5 and 20 pound runs were made. The initial air pressures used with each steam pressure were as nearly 0.6, 1.0 and 1.5 inches as could be maintained, the variations being made by varying the speed of the fan.

Previous to making the runs all instruments were calibrated.

As the velocities of air used were found to be for the most part too high for satisfactory measurement and because the anemometer method is in itself not a reliable one a formula was devised to find the velocity from the pressure readings which was based on the fundamental formula $v=\sqrt{2gh}$. The expression as used was:

in which

$$v=\frac{3132}{1+e}\sqrt{\frac{p\ (t+459.2)}{p+13.58\ B}}$$

v=velocity of air in ft. per min. over first coil.

e=percentage of air expansion.

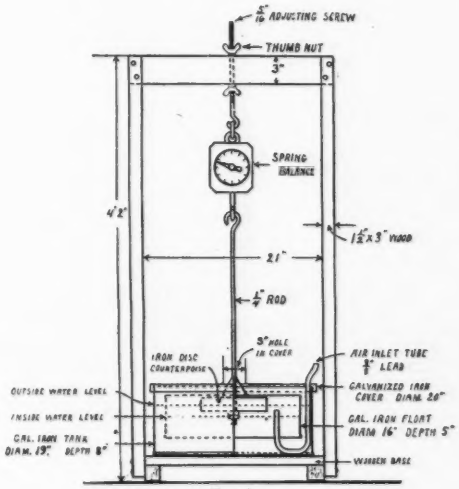


FIG. 4.

AIR PRESSURE GAUGE

Dial graduated to read inches of water.

Scale------1½ in.=1 foot.

p=air pressure gauge reading at delivery.
t=thermometer reading at delivery.
B=barometer reading (Quantity No. 1, See Data Sheets).

A coefficient of contraction of .61 for the discharge opening was assumed since it was a thin plate with rectangular opening and full contraction. This coefficient was included in the constant 3132.

The temperatures observed were those of the calorimeter and of the condensed steam as read from the thermometers placed in cups fitted into the drain to the water column from each radiator. The temperatures of the received and delivered air were measured by the thermometers shown which were located by trial to give the average temperature in the passage. The room temperature given is the average of the readings of thermometers on either side of the duct about six feet from the floor. The air pressures are given for the entering air between each pair of sections and in the discharge end.

Below each set of data are given the barometric reading and the absolute steam pressure in the coils corresponding to the gauge reading above.

Quantity No. 4 was taken to be the total heat of the steam per pound less that contained in the water at the temperature given for the condensation and all multiplied by Quantity No. 3.

Quantity No. 8 was estimated as the total outside surface of the radiator used less the area of the back of the vertical and the bottom of the horizontal headers.

Quantity No. 9 was considered to be equal to the velocity of the air in feet per minute multiplied by a constant of 2.6 which was the area in square feet of the cross sectional opening around the coils and between the pipes.

Quantity No. 11 for the total is the difference between the temperatures of the entering and leaving air and the increase in temperature due to each radiator was made proportional to the condensation as given in No. 12.

Quantity No. 13. Total=No. 12 divided by (No. 8 multiplied by No. 7) while for each radiator the number is found by dividing its condensation by the difference between the temperature of the steam and its mean air temperature and by its area.

Quantity No. 14 gives the difference between the successive air pressure readings and that between the received and delivered air.

In Tables I, II, III, IV and V are given summaries of the results obtained.

Exhibit "A" is the complete data of one test and is submitted as a sample sheet.

EXHIBIT "A."

DATA OF TESTS OF HOT BLAST HEATING COILS.

MECHANICAL ENGINEERING LABORATORY. IOWA STATE COLLEGE.

No. of Sections, 4; Steam Pressure, 20 lbs.; Vel. of Entering Air, 1036 ft. min.

	TEMPERATURES								AIR PRESSURES				
		Condensation				Air			Inches of Water				
TIME	Cal.	Rad. No. 1	Rad No. 2	Rad. No. 3	Rad. No. 4	Rec.	Del.	Room	Rec.	½	⅔	¾	Del.
4:05	256-0	252	253	252	254	81-5	162-0	82-5	1-590	1-300	-930	-570	-255
4:15	356 0	252	253	252	254	82-5	163-0	82-0	1-590.	1-300	-930	-565	-250
4:25	255-0	252	253	252	254	81-5	162-5	80-5	1-590	1-300	-930	-565	-250
4:35	252-5	252	253	252	254	82-0	163-0	81-5	1-590	1-300	-930	-565	-250
4:45	251 0	253	253	252	254	82-5	163-0	81-0	1-580	1-290	-925	-560	-250
4:55	252-0	252	253	252	254	81-5	162-5	81-5	1-585	1-295	-925	-560	-250
5:05	251-0	252	253	252	254	81-5	163-0	80-5	1-590	1-300	-935	-565	-250
Ave.	253 3	252-1	253	252	254	81-8	162-7	81-3	1-588	1-298	-929	-563	-251

TABLE I.

B. T. U. PER HOUR TRANSMITTED.

FOR STEAM PRESSURES OF FIVE TO TWENTY-FIVE POUNDS.

One Radiator. Air Pressure.			Pounds	Two Radiators. Air Pressure.		
.6 in.	1 in.	1.5 in.	Steam.	.6 in.	1 in.	1.5 in.
115300	152700	161000	5	200100	241800	276000
129700	172800	.....	10	226100	263000	300500
139600	175600	169800	15	241000	278800	315500
154700	178600	199000	20	243500	295800	345200
159200	196000	211200	25	257200	314800	353200

TABLE II.

B. T. U. PER HOUR TRANSMITTED.

WITH ONE, TWO, THREE AND FOUR RADIATORS IN HEATING DUCT.

Steam Pressures.	No. of Radiators.	Sq. Ft. Surface.	Air Pressure. .6 in.	1 in.	1.5 in.
Five Pounds.	1	62.5	114900	152800	161000
	2	125.	200100	241800	276000
	3	187.5	275000	343200	380800
	4	250.	254000	366000	422200
Twenty Pounds.	1	62.5	154700	178600	199000
	2	125.	243500	295800	345200
	3	187.5	323800	402100	464000
	4	250.	317600	435000	505000

TABLE III.

STEAM CONDENSED PER HOUR WITH FOUR RADIATORS IN HEATER.

FIVE POUNDS STEAM. Air Pressure.			Radiator	TWENTY POUNDS STEAM. Air Pressure.		
.6 in.	1 in.	1.5 in.	Number.	.6 in.	1 in.	1.5 in.
77.4	101.8	114.6	1	96.9	127.9	146.7
61.5	81.9	92.6	2	76.2	103.4	119.8
55.2	75.6	87.1	3	67.9	96.	109.8
45.	64.1	75.5	4	56.8	82.3	94.5

TABLE IV.

AIR PRESSURE.

Tables for .6 in., 1 in. and 1.5 in. Respectively.

FIVE POUNDS STEAM						No. of Rad.	TWENTY POUNDS STEAM				
	PLACE OF READING						PLACE OF READING				
	Rec.	½	⅔	¾	Del.		Rec.	½	⅔	¾	Del.
0.6 in.	.582	.296	.....	.....	.....	1	.585	.287	.....	.....	.....
	.614	.416	.086	.....	.....	2	.620	.415	.085	.....	.....
	.579	.459	.284	.049	.....	3	.571	467	.290	.050	.....
	539	.439	.324	.189	.075	4	.533	.440	.324	.195	.075
1.0 in.	1 027	.502	.....	.....	.....	1	1.062	.512	.....	.....	.....
	1.070	.709	.153	.....	.....	2	1.080	.711	.156	.....	.....
	1.065	.823	.508	.085	.....	3	1.065	.830	.508	.085	.....
	1 040	.839	.611	.384	.160	4	1.060	.857	.622	.389	.160
1.5 in.	1.464	.723	.....	.....	.....	1	1.461	.719	.....	.....	.....
	1.471	.954	.212	.....	.....	2	1.510	.981	.219	.....	.....
	1.476	1.081	.677	.114	.....	3	1.510	1.113	.697	.118	.....
	1.530	1.235	.896	.541	.....	4	1.588	1.298	.929	.563	.251

TABLE V.

Condensation Pounds per Square Foot per Degree.

Difference of Temperature per Hour.

STEAM PRESSURE	Nominal Air Pressure	NO. OF SECTIONS			
		1	2	3	4
	0.6	0.0145	0 0128	0.0108	0.0095
5	1.0	.0179	.0152	.0130	.0118
	1.5	.0195	.0166	.0143	.0134
	0.6	.0147	.0130		
10	1.0	.0179	.0154		
	1 5		.0168		
	0.6	.0148	.0131		
15	1.0	.0179	.0155		
	1.5	.0201	.0171		
	0.6	.0151	.0130	.0111	.0097
20	1.0	.0170	.0161	.0135	.0122
	1.5	.0203	.0172	.0150	.0141
	0.6	.0151	.0132		
25	1.0	.0184	.0161		
	1.5	.0207	.0174		

1. Barometric pressure 129.93 in. Hg.

2. Absolute steam pressure in coils, 34.2 lbs.

3. Quality of steam, 114 per cent.

4. Heat transmitted per pound of steam, 107.2 B. T. U.

5. Temperature of steam, 257.8 deg. F.

6. Mean temperature of air, 122.2 deg. F.

7. Difference between steam and mean air temp., 135.6 d. F.

8. Area of radiating surface, 250 sq. ft.

9. Volume of air received, 2,692 cu. ft. per min.

10. Increase of air volume, 15 per cent.

	Rad. No. 1	Rad. No. 2	Rad. No. 3	Rad. No. 4	TOTAL
11. Increase of air temperature	25-2	20.6	18-9	16-2	80.9 deg. F.
12. Condensation per hour	146-7	119-8	109-8	94-5	470-8 lbs.
13. Condensation per hr. per sq. ft. per deg. diff.	-0144	-0136	-0145	-0146	0141 lbs.
14. Air pressure loss by friction	-290	-306	-366	-312	1-337 in. W.

Greenhouse Heating

Two interesting questions regarding greenhouse heating were propounded recently to the editor of *The American Florist*. The first was:

"I am thinking of installing one boiler in my greenhouses to take the place of the two I now use. I have about 12,000 feet of glass and may possibly add 1,500 feet more. I use steam and grow roses, carnations and pot plants. What size boiler would it take to heat it properly? The temperature sometimes goes to 22 degrees below zero."

"A good deal," was the reply, "depends upon the construction of the houses, the exposed wall surface and the method used in estimating the area of glass. It would probably be safe to use a 50-horse power boiler if the actual surface of the exposed glass is no more than 14,000 square feet."

The second question referred to the arrangement of pipes in a greenhouse:

"Please state the quantity and size of pipes necessary for heating a small house, 17½x108 feet. The side walls are four feet high, sheeted with two 1-inch boards, two-ply felt paper between, with heavy coat of mortar over all, outside. Six-foot bench down center and one four-foot bench on each side. The house runs east and west and the center bench is cut in two for a walk. How shall I arrange the pipes?"

"It will not be possible," was the answer, "to give a very definite reply to the question, as it does not state whether steam or hot water is to be used, and no hint is given regarding the temperature desired or the kind of crops to be grown. In a general way, if hot water is to be used for heating, it will answer to use three 2-inch flows and from six to eight 2-inch returns for a temperature of from 45 degrees to 55 degrees. For roses or crops requiring about 60 degrees it will be well to use ten returns, supposing that the outside temperature is about zero. For steam under the above conditions, use one 2-inch flow and from six to eight 1¼-inch returns."

THE SCIENCE OF VENTILATION—THE ADVANTAGES AND LIMITS OF "NATURAL" AND "MECHANICAL" SYSTEMS COMPARED*

By J. D. Sutcliffe

The science of ventilation is a big subject, and no system is suitable for all buildings and every circumstance. It is a pity that in recent discussions real issues have been kept back by those commercially interested in some particular system, who have strung perverted quotations together to prove their own case or to damage other systems. As a case in point, no doubt many of you have received a little Blue Book purporting to be a report on the House of Commons' ventilation, in which it is sought to prove that a Committee of the House of Commons decided against mechanical ventilation, whereas their recommendations were: First, to increase the size of the fan propelling fresh air into the House; and second, to fix fans for exhausting the air instead of heated upcast shafts which had been in use up to that time.

Holding no brief for either the "Mechanical or "Natural" systems, I propose to place before you the advantages and limitations of both so far as my experience and practice will allow.

STANDARDS OF EFFICIENT VENTILATION

In specifying satisfactory ventilation it is not enough to merely prescribe a certain air space per person, though this is good, or even to fix a certain supply or renewal of air per person, though this is better, but in all cases a standard of CO_2 should be definitely fixed. In schools a cubic space of 120 ft. per child is deemed sufficient by our educational authorities who do not realize that the place for children is in the open air and if this is not possible then they should have the nearest approach to it that can be given. In factories the minimum space for each worker varies from 250 to 500 cubic ft. according to the healthiness or otherwise of the trade. All authorities are agreed that 3,000 cubic ft. of fresh air per hour is necessary for a man if he is to breathe reasonably pure air. The standard in the Massachusetts and most American schools is 2,000 ft., whilst in our own schools we have no standard whatever.

Now with regard to the standard of purity which ought to be maintained. In cotton cloth factories where artificial humidity is used the CO_2 must be kept down to below 9 parts in 10,000 parts of air and so far as I know these factories are the only buildings in the United Kingdom compelled to ventilate to a definite standard of purity by law. My own idea is that the ventilating engineer should aim at a standard of 5 or 6 parts of CO_2 under normal conditions and 9 parts of CO_2 as a maximum under any circumstances.

There is not the least difficulty in keeping the CO_2 in any room down to below the standard required by the cotton cloth factory act and this is shown clearly by the report of Mr. Scudder, the chemist who was recently requested by a Committee of employers and employees to take samples of air from thirty different factories. Mr. Scudder took two hundred and eighty-seven samples in all and found that only five exceeded the amount allowed by the Act. Further proof is given in the chief factory inspector's report for 1903, where the results of over fifty different tests are given. Some are as low as 4.6 parts of CO_2 the majority between six and eight parts and only nine above the standard allowed.

It seems somewhat hard on cotton cloth factory owners to be compelled to keep the CO_2 down to 9 parts in 10,000 of air when it is safe to say

*From a paper read at the recent annual meeting of the British Institution of Heating and Ventilating Engineers.

there are very few schools in England (certainly not 5 per cent.) that would pass the same test two hours after lessons had commenced and there are many schools where the CO_2 reaches 18 or 20 parts per 10,000 before the end of the afternoon. The nose is usually an excellent guide to the presence of impure air, as when anybody fresh from the outside enters a room a faint smell is perceived if the air contains 7 parts of CO_2 per 10,000 and when it reaches 8 or 9 parts we usually say the room is "close."

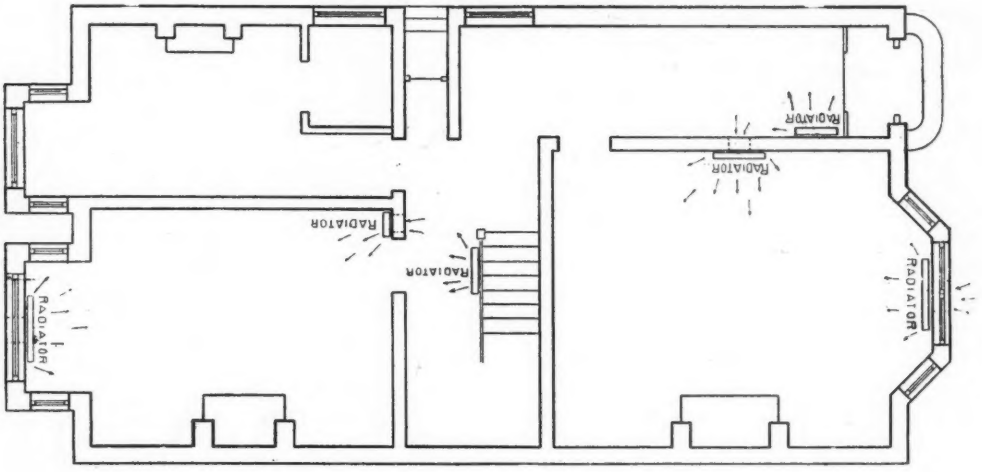
NATURAL OR AUTOMATIC VENTILATION?

"Natural" ventilation is not the correct term to use in the sense that it is used to-day by all the makers of cowls who arrogate to their own particular system the word "natural." A much better term is "automatic" ventilation to distinguish it from "mechanical" or "fan" ventilation. My idea is that the only "natural" ventilation is outside a building in the fresh sunlit air of heaven.

Of all kinds or systems of ventilation my preference is for the open window. Some of my hearers may say what has the science of ventilaation to do with this, but the ventilaating engineer if he is wise thinks a good deal of the open window and in my opinion there is no system either automatic or mechanical to compare with it. I preach this gospel in season and out and practice it with great benefit to myself and my family.

We have been told so frequently that if we sit in a draught we shall catch cold that we have come to believe it, whereas the true explanation of why we "take cold" is a very different matter. A cold is a germ disease and the surest way to resist an attack is to be surrounded by pure air. I never catch a cold unless I am compelled to stay in a close and stuffy atmosphere such as we sometimes get in a dining car, where the windows are not allowed to be open, or in a crowded hall or theater. When the vital forces are lowered by breathing impure air, disease germs gain an advantage over otherwise healthy tissues and rapidly spread their baneful effects over the whole system and this is how we "catch cold." It is this bogey of taking cold that makes so many people shut themselves up in almost air-tight rooms and yet, strange as it may seem, this is the very surest way of catching what they desire so much to avoid.

I am going to go further and say not only that draughts are not dangerous but since they are inseparable



Ground Plan of House with best positions of Radiators.

from a constant and plentiful supply of fresh air they are to be cultivated.

Look at the thousands of consumptives who are now living this open air life and if anyone suffered from it, surely these frail mortals would. A year ago last October a friend of mine who was threatened with consumption went to spend some months at a sanatorium on the most exposed portion of the Cotswolds. He had been used to being coddled by his family but the doctor at the sanatorium told him at once he could put his overcoat and his hat away during his visit as he would not require them. At first he felt very cold and miserable as the house was without windows, but after a while he became used to the new conditions and at the end of a week he was so much better in health that he felt life was worth living again. He stayed all through the winter and until the following April, and told me that he frequently played chess sitting under a hedge in the snow and was always without overcoat or hat. He never had a cold during his visit, returned a healthy man and is now a confirmed disciple of the open window and life in the open air.

After what I have said in praise of the open window I fancy I can hear some of you asking, "Well, but where is the work for the ventilating engineer if the open window is so desirable?" There are, however, a large number of buildings, such as factories, theaters and some schools which cannot be ventilated by open windows.

AUTOMATIC VENTILATION

Returning again to automatic ventilation, this can as a rule be very well applied to an ordinary house and Fig. 2 shows a ground plan of my house with the warming and ventilating arrangements clearly marked. There are two hot water radiators fixed in the hall, one near to the inner door and the other at the side of the staircase, while there are also radiators under each window and one in each room with their backs to the hall. The four radiators in the rooms are all of a ventilating pattern as Fig. 3, the two under the windows having fresh air brought to them from the outside and the other two from the hall where it is always fresh and pleasant. I have also fixed an outlet near the ceiling and this is an excellent plan of taking off the products of combustion from the burning gas.

I am not greatly in favor of the ordinary Tobin Tube. It is unsightly and if of sufficient length to be of any use it is difficult to keep clean. I much prefer air inlets and if these are fixed about 6 ft. 6 in. from the floor they answer their purpose well.

I should like to mention here a point in the construction of windows that I think is worth attention. All windows should be carried up to the ceiling level, so that when they are opened at the top the heated and vitiated air of the room will have a much better chance of escape than if the top of the windows were 18 ins. or 2 ft. below the ceiling.

Schools or similar buildings of reasonable size and width can be very well ventilated by automatic appliances, but to insure a thoroughly satisfactory system of automatic ventilation the school should be only one story high and not more than 30 ft. wide. The warming and ventilation should be combined. The best plan is to use single flue ventilating radiators fixed under each window with fresh air admitted behind each radiator. If the weather is suitable the windows can be opened for additional air supply, and the only other thing necessary is a series of good-sized outlets at the ridge of the roof.

It is frequently claimed by manufacturers of patent cowls that their particular make will produce strong extraction currents of air in all weathers. This is a claim I have never been able to substantiate, and in my experience the best roof ventilator is the one which allows the air to pass out with the least obstruction and yet is weather tight. Years ago

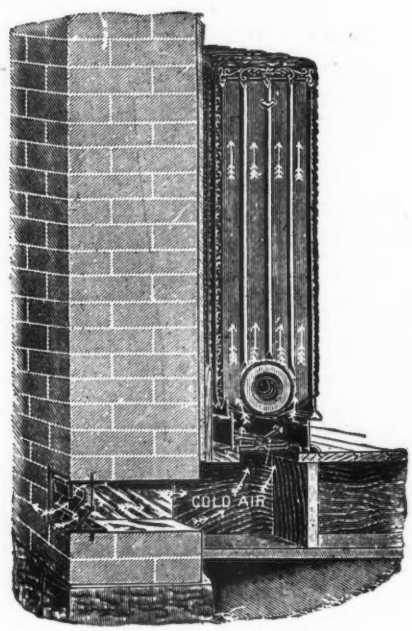
I assisted in testing some large Archimedian screw ventilators on the roof of the Manchester Art Gallery. Some had rusted fast and would not revolve, while others whirled round merrily when any wind blew. We fixed anemometers under several and found that the ventilators which were stationary allowed more air to pass out than the revolving ones, and Mr. Allison, the late City Surveyor, had them all fastened.

From all these ventilators you will, however, get down-draft under certain conditions, and it is well to remember that they are only outlets for air and not effective exhausts in the true sense of the term.

If a really effective automatic extractor is wanted, heat will have to be used in one form or another. A good-sized Bunsen burner fixed just above the ceiling line in an outlet turret is a help, but a better arrangement is to use a special heating battery. Such an outlet really gives extracting power, and with it there is no possible chance of a down-draught. I must warn you that it is not safe to heat such a battery from a hot water supply on account of the considerable danger of freezing and bursting in frosty weather. Steam is the only suitable heating medium.

HOT WATER OR STEAM HEATING?

This brings me rather sharply to the question of the advantages and disadvantages of steam and hot water for heating purposes. Personally, I prefer hot water radiators for private houses, offices and other rooms that are not overcowded, but are usually occupied by the same number of people. With hot water, however, larger heating surfaces are required to get the same temperature effect, and also much larger pipes, while another disadvantage is that the heat is not so readily controllable. Using steam you will have useful heat from the radiators inside an hour after lighting the boiler fire, whereas with hot water several hours usually elapse before any heat is available. There is also the corresponding drawback when you want to shut off the heat quickly. Directly the control valve is turned off the heat disappears when steam is used, but in a hot water installation the heat remains a long time in the radiators and the overheating may become serious. Where you have at one time a building crowded out and at another time the same building less than half full, it is essential to use low-pressure steam, as it is so much more amenable, and you can raise or lower the temperature to suit the conditions in a few minutes. Then, again, in cold and frosty weather, hot water pipes



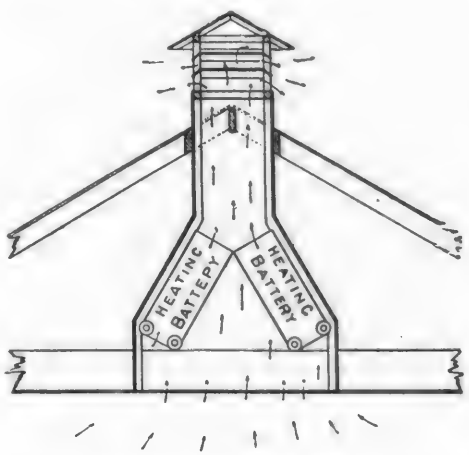
Ventilating Radiator.

FIG 3.

are liable to burst if the apparatus is out of use for a few days, whereas with steam this cannot happen. One advantage of hot water heating is that the temperature of the radiators or other heating surface is lower than with steam heating, so that the air is not raised to such a high temperature, but with low-pressure steam heating the difference is comparatively little. In no case do I recommend high-pressure steam heating, and in my opinion, 2 to 5 lbs. is quite as high as it is necessary or desirable to go.

CHURCHES

Churches are also buildings in which it is better to use a natural or automatic system rather than a mechanical or plenum system, and they can be warmed quite well on the lines laid down for small schools. The chief difficulty is the cooling of the air by the large windows and the roof which causes considerable down-draughts. These can be avoided or minimized by using steam batteries in the roof outlets, as previously illustrated, and running one or two rows of small steam pipes round the church at the level of the eaves. If hot water is used for heating it is a very simple matter to use also a small separate steam boiler specially for the ventilation. What one should particularly avoid in the heating of a church is the usual channels sunk into the floor with steam pipes in them and gratings over. They are always foul receptacles for dust and dirt, and can never be properly cleaned.



Air Outlet, with Heating Battery.

MECHANICAL VENTILATION

Many of the difficulties that are met with in automatic ventilation disappear when fans are used. The necessary amount of air is obtained by simply choosing the right style and size of fan, and driving it at the proper speed. The only problem—a serious one, I grant—then lies in the correct distribution of the air.

The movements of air currents have not been sufficiently studied, and I think sometimes it is a misfortune they are not visible. If fresh air were colored blue and when it became foul it blushed a delicate pink, we should be able to deal with it better. I know a great many halls, schools and other rooms where there would be a good deal of blushing. At present, unfortunately, we know very little of the behavior of air, and if we could only see it, many things which now puzzle us would be made clear. The difficulty with all air currents is in controlling their direction. For instance, if you admit air into a room, say, on a side wall at 6 ft. 6 ins. from the floor, and direct it upwards to the ceiling, what happens? Well, that will depend on the temperature of the incoming air in relation to the air in the room, and will constantly alter as the temperature and velocity vary. If the air enters at considerably higher temperature than that in the room the warmer air will go to the ceiling and probably diffuse itself there, traveling along to the opposite wall and then cooling and coming down, or passing out at any opening that may be provided. If the admitted air should be colder than that in the room it will probably never reach the ceiling, and will certainly not cross the room unless a fan pulls it, and even then it may travel along the floor. Of course, any intermediate stages of warmth will give intermediate stages of direction and velocity.

VELOCITY OF AIR CURRENTS AT INLETS

The velocity of air coming into a room has a great deal to do with the comfort of the occupants. Ventilating engineers generally say that if the velocity does not exceed 5 ft. per second there is no perceptible draught. This needs qualifying, as a great deal depends on the occupants. A thin, spare man who takes little outdoor exercise can feel a draught where a healthy man feels none, and until some device of enveloping each man in his own particular temperature and

in his own pet air current is introduced, it will be difficult to suit everybody. With all systems of automatic ventilation there is the difficulty of keeping the velocity of air constant. If a strong wind is blowing on one side of the building the air enters the inlets on that side at a much more rapid rate than it does on the leeway side or on a still day.

I remember discussing some ventilating plans of a new technical school with an architect, who told me he had decided to adopt a certain scheme because the ducts and air inlets were so much smaller than in any of the other plans. He instanced a room for twenty pupils with an inlet only 6 inches square and pointed to the difference between this and another plan where the inlet was 18 inches square for the same room. I told him that if 3,000 cubic feet of air per hour per pupil were supplied the velocity at the inlet would be 66.6 ft. per second, whereas with 18 inches square it would only be 7.4 ft. per second. On the other hand, if the velocity were to be kept down to 4 ft. per second each poor pupil would only get 180 cubic feet per hour, while with the larger inlet they would each get 1,620 cubic feet per hour. Many ventilating contracts have no doubt been given out for similar reasons, but no architect is likely to make such a serious mistake more than once.

THEATERS AND SIMILAR PUBLIC BUILDINGS

Theaters and public buildings have frequently no windows in the auditorium, they are surrounded by corridors and other rooms, they have several tiers or galleries, and no system of ventilation but the plenum is of any use. In the balconies and circles of theaters the cubic space allowed to each person is so limited that unless a large quantity of air is positively forced into them they become foul in a very short time. There are many theaters where the height between the floor and ceiling of the circles is less than 7 ft., while the space from back to back of the seats is barely 2 ft. 6 ins., and each seat only occupies 1 ft. 6 ins. in width. This practically means that each person is in a cubicle containing only 27 cubic feet, and it requires no stretch of the imagination to see how rapidly the air in such a small space becomes impure. Another difficulty is that the pittites are fully dressed and often wearing their overcoats, while the occupants of the stalls on the same level are very scantily clothed. It therefore follows that what is a comfortable temperature for one is a disagreeable one for the other and the stalls may always with advantage be 5 or 6 degrees higher in temperature than the pit proper.

My own idea of ventilating a theater is to have an underground main air duct, say, 6 ft. high and 3 ft. 6 ins. wide all round the auditorium wall. Into this duct fresh air should be forced by means of a fan or fans and then five or six vertical air ducts led from it to each of the various tiers. In this way the air will be distributed to all parts of the auditorium. The pit and stalls are best ventilated by small platforms or risers running under several rows of seats right across the theater. Under the small platforms should be pipes for heating so that the incoming air may be warmed to a suitable temperature. The temperature and air supply can be controlled by an attendant in the main air duct. If he wishes to partially or wholly close off the air supply he adjusts the horizontal sliding door. If warmer air is wanted he pulls the door above the heating battery forward and all the air passes through the battery; if cooler air, he pushes the door back as far as necessary. A very simple form of indicating thermometer fixed in the main air duct shows the attendant what is the temperature in every part of the theater.

For the extraction of the vitiated air there is nothing better than a large sunburner, but these are being gradually superseded by electroliers. Now an electrolier is practically use-

less as an extractor and it is necessary to supplement it with an exhaust fan of sufficient power.

The entrances and stage need only be warmed by radiators and do not require any special ventilating arrangements. Low pressure steam is the only satisfactory heating medium, as hot water does not answer readily enough in either heating or cooling to the demands that have to be met.

* * * * *

Although I have only been able to touch the fringe of my subject, I trust the few examples I have given will be useful, and especially that my remarks about the open window will bear some fruit. Fresh air is as necessary as good food if the best is to be obtained from any man.

Every improvement in the factory laws has at first been opposed by the majority of employers, but as soon as the improvement has been made the manufacturer has wondered how he and his men tolerated the old conditions. The Home Office have generally done their work exceedingly well, and what is wanted now is a strong public opinion to wake up our Education Department to a sense of their duty! The air in the majority of the schools in the United Kingdom is a standing disgrace to the authorities, and a serious menace to the health of the nation.

VENTILATION OF TUNNELS AND SUBWAYS

By Albert A. Cary

[EDITOR'S NOTE.—In the following papers Mr. Cary has dealt more fully with some of the interesting topics discussed at the recent meeting of the American Society of Heating and Ventilating Engineers.]

In July, 1901, during the Grand Jury's investigation of nuisances existing in the Park avenue tunnel between Fifty-sixth and Ninety-sixth streets, in New York city, I was retained by the District Attorney of New York county as engineering expert in ventilation, and in my testimony before the Grand Jury I described a system of ventilation which may prove of interest.

The greater part of the Park avenue tunnel (as it is called) might be considered more as a partial subway. It contains four tracks, the two outer ones being placed (during the greater part of the tunnel's length) in what is known as the side tunnels, while the other tracks are located in one "center tunnel." The greater part of the center tunnel has openings in its top while the side tunnels are closed excepting a series of archway openings in the top of the 20-inch dividing walls, separating them from the center tunnel. Thus, a part of the steam, gases, smoke and cinders escape through these openings into Park avenue and become a nuisance as they blow into the adjoining houses, as was testified by numerous witnesses.

Park avenue is a broad street measuring about 96 feet in width from curb to curb. Through the center of the avenue are located a series of parkways about 40 feet in width and slightly less than 200 feet in length, their ends at the intersections of the crossing streets being semi-circular. In the center of the parkways the openings from the center tunnels are located, while grass and shrubbery surround these openings extending to the stone copings around their outer edge and on these copings an ornamental iron fence is placed.

Over the four tracks running through this tunnel all the trains passing in and out of the Grand Central Depot are run, and these include the trains of the New York Central & Hudson River Railroad; the trains of the Harlem Division of the New York Central & Hudson River Railroad; and those of the New York, New Haven & Hartford Railroad. Between 500 and 600 trains pass through this tunnel every day and at times there

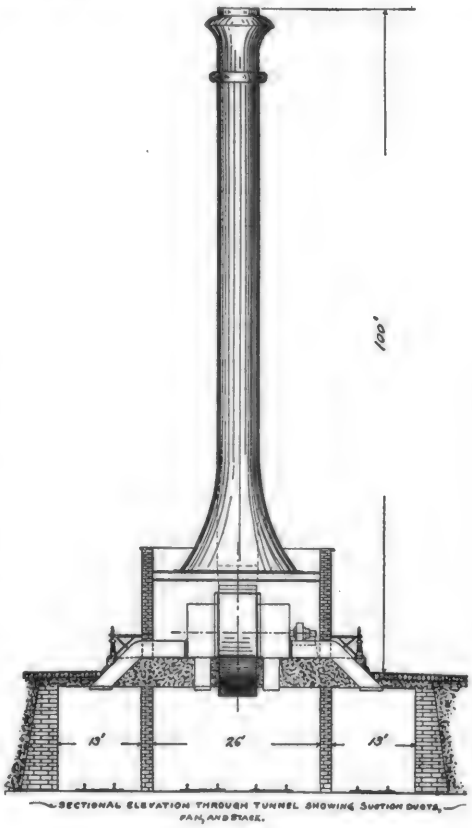
is but 50 seconds headway between trains. The average time required by trains to traverse the tunnel is about 3½ seconds when no stops are made and no delays encountered.

The condition of the atmosphere in the tunnel and that in the passenger cars passing through the tunnel were investigated by Dr. Cyrus Edson (formerly President of the New York Board of Health), Dr. Chas. A. Doremus, and by officers detailed for this purpose by the Board of Health, and Dr. Edson in his report made the following statements:

"In my opinion, the tunnel is the cause of a very serious public nuisance, affecting the health and comfort of a very large number of persons. This is mainly caused by the gases of combustion and other deleterious gases, which enter the cars passing through the tunnel, and the lack of proper ventilation of the tunnel and the cars. Each car contains less than 5,000 cubic feet of air-space and therefore allows only about 56 cubic feet of air for each person. In the case of the "Black Hole" of Calcutta, 146 persons were thrown into a room the size of an eighteen-foot cube at eight o'clock in the evening. The room contained a door and two windows. The latter were open. Each man had about 38 cubic feet of air space, and yet by 11.15 all were dead but 26, most of whom later succumbed to fever. The only cause operating to this effect was the exhaustion of the oxygen of the air."

"On Tuesday, the 23d inst., I boarded the 5.45 P. M. train which passes through the north-bound side tunnel and the following observations were taken in car No. 1024, the temperature of the air at Forty-second street being at the same time 88° Farenheit. The temperature in the car at the station was 95° and within four minutes the car's temperature had risen to 103°; while the humidity in the air in the car at departure was 70 per cent., it rapidly rose within four minutes to 81 per cent. The humidity at Forty-second street, opposite the depot, before the departure of the train, was 62 per cent."

"On Wednesday, July 24, I made a number of observations of cars in transit through the tunnel. One was on the 12.15 P. M. train on the Harlem Road. The temperature of the car at starting was 86.5°. Within four minutes, during transit, it had risen to 91° and the humidity rose from 70 to 76 per cent. The air was very irritating and several



SECTIONAL ELEVATION THROUGH TUNNEL SHOWING SUCTION DUCTS, FAN, AND STACK.

VENTILATION OF TUNNELS. FIG. 1

persons were seized with coughing spells. On entering the tunnel my pulse was beating at the rate of 70 per minute. At the exit it had risen to 96 per minute."

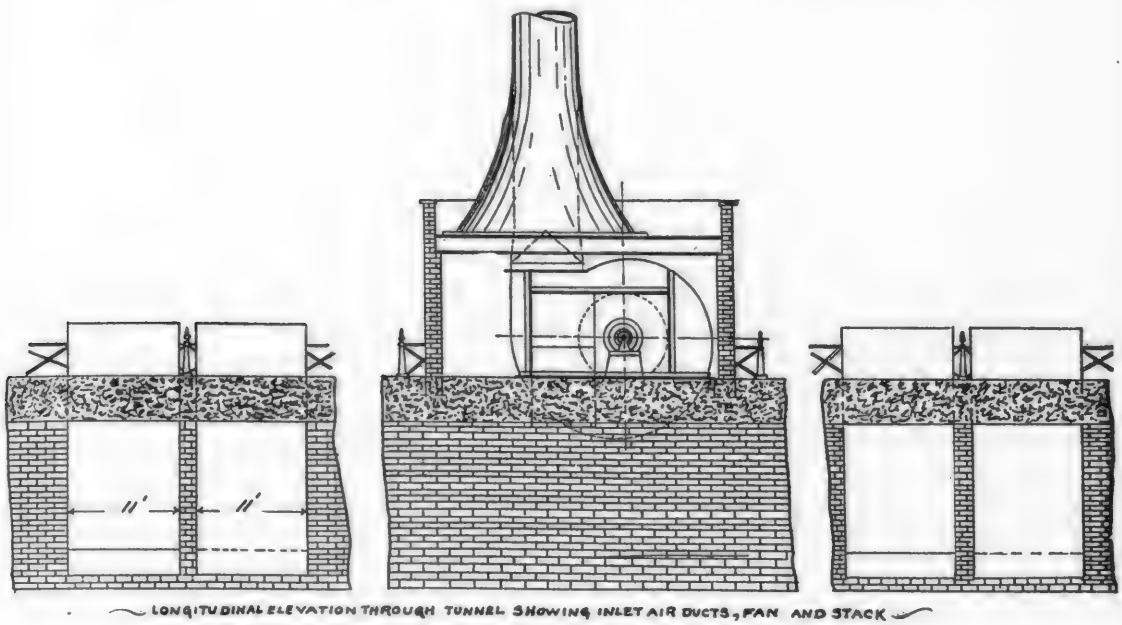
"On the 5.03 train for Port Chester, on the New Haven Road on July 25, the temperature at starting was 82° and on exit 93°; percentage of humidity at starting 64, at exit 98; the time of passage three and a half minutes. The car was light-

ed with oil-lamps and though the seating capacity was for only fifty-two, there were sixty persons in it, giving less than fifty-six cubic feet of air-space to each one. On leaving the tunnel the windows were all opened and within five minutes the temperature dropped to 79° and the humidity to 60 per cent."

"The temperature in these cars during the warm weather varies from 85° to 105°. I have noted a temperature of 111°, with a high percentage of humidity. The gases of combustion, plainly apparent to the senses while the cars are passing through the tunnel, are very poisonous and in sufficient quantities will destroy animal life."

After a careful consideration of the existing conditions of nuisance and after studying various methods for its suppression, I have arrived at the conclusion that mechanical ventilation was the most practical solution of the problem, which conclusion led me to submit the system described in this discussion, to accomplish the rapid removal of the greater part of the smoke, steam and noxious gases from the tunnel and at the same time providing for the introduction of an ample supply of fresh air into the tunnel.

By this system the atmosphere in the tunnel could be kept constantly in a condition of sufficient purity to be breathed by those passing through it, without danger to health, and the humidity and temperature will be maintained at a very slight excess above that of the outside air, and thus the general discomfort of the passengers will be reduced to a minimum.



VENTILATION OF TUNNELS. FIG. 2

It will be seen that I have made ample provisions to meet the objections offered by those residing on that part of Park Avenue occupied by this tunnel, by erecting chimneys over the outlets of the fans used, thus discharging the steam and noxious gases at a considerable elevation above the roofs of these houses, instead of allowing them to issue at a level of the street (as at present).

With the steam and gases discharged above the roof level, the moving currents of air found there will carry them rapidly away and

dilute them with the surrounding air so as to cause no more local nuisance than is made with the many factory and domestic chimneys about this city, and further, these discharged gases will be so diluted with the fresh air supplied to the tunnel they will be, at the point of discharge, far less of a nuisance than the gases and steam now escaping from the openings over the center tunnel.

In any system of ventilation it is a positive necessity for successful working to have the air enter and leave only at the points designed, and therefore it will be understood that it will be necessary to entirely close the openings over the top of the central tunnel, now left open, and fresh air will then have a positive inflow through the intake ducts provided, while the foul atmosphere is positively discharged through the suction openings leading to the fans.

By referring to the accompanying illustrations three sectional views of the tunnel will be seen, marked Figs. 1, 2 and 3. The views of the tunnel shown here are drawn from dimensions obtained by me between Sixty-first and Sixty-second streets.

In Fig. 1 is shown a sectional elevation at a point about midway between tween Sixty-first and Sixty-second streets, where I propose to place the suction fan and chimney. The fan casing will be seen (with its lower portion shaded) above the middle of the center tunnel. On each side of the fan casing will be seen inlet air boxes, which collect the foul air from the suction flues, and this air is drawn from these boxes into the fan casing, from whence it is discharged through the chimney into the outside air.

The suction flues (discharging into these inlet boxes) are four in number, the suction ends of which are placed directly over the center of the four tracks shown, and as I propose to place a fan in the center of each block, it will be seen that the locomotive smoke stack will pass under one of the exhaust openings about every 250 feet.

I would call your attention to the fact that this design includes all of the necessary flues and other parts entirely within the limits of the central parkway without encroaching upon the adjoining street. The chimney shown in this design is constructed of steel plates and made graceful in outline, as shown. It is to stand 100 feet above the street level and to be 7 feet in diameter. It has a bell shaped base designed to be self-supporting (i. e., requiring no guy ropes), and is to stand upon a proper brick foundation, the details of which are not shown in the illustrations.

It will be seen that I have designed the foundation of this chimney so as to form a house around the fan, and thus the parkway is robbed of the least possible amount of space. This chimney base (or fan house) can be built of neat architectural design, so as to avoid a disfiguring effect to Park avenue.

Fig. 2 shows a longitudinal section of the tunnel from a point (at the left) just south of Sixty-first street to a point (at the right) just south of Sixty-second street.

It will be understood that the three broken parts shown in this view are supposed to be filled in between the two central breaks, so that the illustration includes a length of somewhat more than a block along Park avenue, and thus it shows the relative position of the inlet fresh air pipes and the outlet flues connecting with the exhaust fan.

It will be seen that four inlet fresh air pipes are placed near the north end of each of the parkways, and with an average distance of 125 feet from the suction pipes of the fan. These fresh air pipes drop to a point about 15 inches above the bottom of the tunnel (to prevent water entering their lower end) where they turn with an outlet towards the center of the tunnel they supply with air. Thus it will

be understood that with the two inlet pipes placed side by side, one turns its lower end towards the center tunnel, while its neighbor turns its lower end in the opposite direction, towards the side tunnel.

This is shown in the sectional view herewith. Owing to the extremely limited space in the tunnel, I have arranged the fresh air flues so as to fit into cuts made in the 20-inch wall separating the center and side tunnels, and thus these flues extend but two inches into each tunnel beyond the surfaces of the present walls. Provision can easily be made to carry the roof beams of the tunnels on structural steel work where these flues are placed.

The upper ends of these fresh air ducts extend about 7 feet above the level of the street (inside of the parkways) and I propose to cover them with ventilators designed to keep out rain or snow.

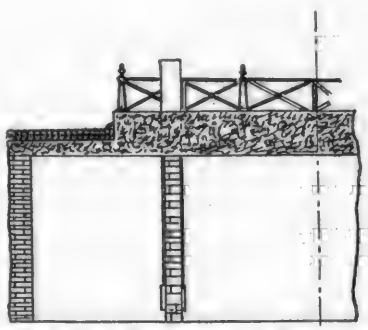
It will now be understood that the foul air from the center and two side tunnels will be rapidly exhausted from the top of these tunnels, and as fast as the foul air is drawn out, fresh air will rush in, entering near the tunnel bottom, and as it rises and passes along the tunnel towards the suction outlets, it dilutes the foul air it finds, so as to render it harmless to those who breathe it, and at times it will almost entirely displace the impure atmosphere and approximate the purity of the outside air.

To obtain a constant supply of air as pure as that outside, when trains were passing the tunnel every fifty seconds, would require an unreasonably large outlay, and as air of such purity is not obtained in the best ventilated buildings we should not expect to have it in this tunnel.

The amount of carbonic acid found in the air is generally taken in ventilation work, as the index of its purity, and what is commonly considered as pure country air ordinarily averages about 4 parts per 10,000 of carbonic acid. Eight parts per 10,000 of carbonic acid is commonly considered as a standard of purity in the ventilation of buildings, while in this tunnel should the carbonic acid present occasionally reach 12 parts per 10,600, no serious inconvenience would be experienced by the passengers, and therefore taking twelve parts per 10,000 as a maximum allowance, with fans of sufficient capacity to exhaust all the air from this tunnel every two minutes, this result could be obtained.

I have included such a fan in my design, which is 12 feet in diameter, to be run at 120 revolutions per minute and requiring 40 H. P. to operate it.

Forty fans of this size (necessary



SECTIONAL ELEVATION THROUGH ½ TUNNEL SHOWING INLET AIR DUCTS IN DIVISION WALL BETWEEN SIDE AND CENTER TUNNEL.

for the complete equipment of this tunnel) would therefore require 1,600 H. P.

I would propose to operate all these fans by electric motors, connecting every alternate fan to a separate circuit, each of the two circuits being supplied with a current from separate engines and dynamos so that in case anything should happen to the machinery connected to one circuit every second fan would still remain in operation.

I would propose that these important wires be placed in subways along the street, so as to guard against breakage due to wind, rain or sleet storms or the operations of the fire department, and I would further install duplicate reserve cir-

cuits connected with the Edison Illuminating Company's system, so as to guard against any possible accident or breakdown.

I would state here that there are many mines now in operation depending entirely upon their mechanical ventilation for the very lives of the miners, and accidents due to stoppage in their ventilating system are unheard of in the modern well equipped plants, and no mine has ever been so amply equipped with ventilating apparatus as this tunnel would be with the equipment offered by me.

Should any one fan be stopped you will doubtless notice that there will still be left free openings to the atmosphere (through the ventilating exhaust ducts, the fan and the chimney). This will always be a free passage to the outside air whether the fans are running or not, and the warmer air in the tunnel will pass constantly up the chimney when the fans are not in operation, as the hot gases from a furnace pass up the chimneys they are connected to.

Returning now to the power required to operate these fans. We have seen above that 1,600 H. P. is required at the fan shafts. Allowing 27 per cent. for losses we would therefore need a central power plant with engines indicating 2,200 H. P. to operate our fans, and this is only a little more than double the power developed by the locomotive drawing the Empire State Express when traveling at the rate of 70 miles an hour (as calculated from cards taken by Mr. Angus Sinclair*).

According to estimates, carefully prepared, the cost of installing this system with all fans, chimneys, exhaust and inlet air ducts, including power house with its complete equipment, electrical installation, tunnel alterations, and everything exclusive of land required for power house, would be but $1,084,000, which is far below the cost of any other proposed remedy worthy of consideration.

This system of ventilating tunnels is by no means untried or new, as you can find the description of a similar method in the English paper *Engineering*, of April 21, 1871, where Mr. Ramsbottom (a well known English engineer) describes the mechanical ventilation of the Liverpool tunnel of the London & Northwestern Railway.

This tunnel is about a mile and a quarter long and has a sectional area of 430 square feet. The ventilation is effected by the use of a single fan 29 feet 4 inches in external diameter, and 7 feet 6 inches wide, placed in a shaft 175 feet high and 23 feet in diameter. With a speed of 45 revolutions per minute this fan cleared the tunnel of smoke and steam in about eight minutes, discharging about 431,000 cubic feet per minute.

The Park avenue tunnel is about two miles long and has a sectional area at the point shown in the accompanying drawing of 841 square feet.

The proposed ventilation, according to my design, is to be effected by 40 fans 12 feet in diameter and 6 feet in width, and these fans with a speed of 120 revolutions per minute will have a combined discharge capacity of 4,120,000 cubic feet per minute, almost ten times the capacity of the English fan, whereas the size of the Park avenue tunnel is only about three times the size of the English tunnel.

Another most important difference between the Park avenue tunnel and the English tunnel, is that the fresh air supply had half the length of the tunnel to travel before reaching the discharge fan, while by my proposed method the fresh entering air is admitted every 250 feet, and the foul air also has a chance to escape every 250 feet.

By this system it will be seen that its first cost will be less than any change in motive power for hauling trains through the tunnel. Its cost of operation and maintenance will

* See *Locomotive Engineering*, June, 1893.

also be less and the time required for its complete installation will be very much less than any other change that has been suggested.

I presented my designs to certain contractors who install ventilating apparatus and received, not only their approval of all that I offered, but in certain cases, some very hearty endorsements and expressions of their willingness to bid on the work and guarantee the results.

All the apparatus I have shown can be obtained in the open market from several manufacturers, and there are no patents restricting the use of this design.

By the system described it will be seen that the present methods of operation in handling trains to and from the Grand Central Depot are in no way interfered with. The present system of train handling is a growth of years and necessarily a complicated one, owing to the immense traffic which has to be handled through this four-track tunnel, which has frequently been compared to the neck of a bottle.

THE REQUIREMENTS OF HOUSE HEATING BOILERS USING BITUMINOUS COAL

By Albert A. Cary

The requirements of all house heating boilers are the same whether they are located in anthracite coal districts or in bituminous coal regions where anthracite coal may be considered as a luxury.

I have found in many cities of the West in the finer residential sections that the problem of burning bituminous coal economically and satisfactorily and without smoke has been dodged, and coke has been substituted as a fuel for the various fires in houses in order to prevent such neighborhoods from becoming besmirched with smoke.

The house heating boiler is quite a different proposition from that found in power houses where an engineer or fireman is in constant attendance to constantly stoke and keep clean the fires under their boilers. In private houses the boilers must be attended frequently by the servant and even the so-called "furnace or handy man about the place," and as these employees have many other duties to perform they cannot constantly stand over a fire and give it the attention required with the use of bituminous coal on ordinary grates, and therefore a fire in a bituminous coal house heating boiler should, in the same way as anthracite fires, be stoked and cleaned at frequent intervals, and between such intervals such a fire should take care of itself in such a manner as will produce satisfactory results, both as to properly heating the house and with the combustion constantly continuing without the production of smoke.

As most of those present doubtless know, there is no trouble in handling anthracite coal fires in a manner to meet the above requirements, as the fires can be cleaned in the morning and a sufficient amount of coal placed on the fire bed to supply the sufficient heat until the middle of the day when a second coaling will carry the fire through until night, at which time the fire may be cleaned and a sufficient amount of coal be charged to continue the fire until the next morning, when it is again cleaned and coaled.

The combustion of bituminous coal is altogether different from the combustion of anthracite; as with anthracite when heated to its ignition temperature, it will take fire and under proper conditions it will continue to burn directly upon the grates from the pure carbon which is the principal constituent of anthracite coal, into carbonic acid or carbonic oxide. I wish to emphasize the fact that the combustion of this coal commences and is entirely completed directly upon the grates.

The combustion of bituminous coal, instead of being a one-stage process, as I have just described, is a two-stage process, as the coal consists not only of a certain amount of fixed carbon, the same as is contained in the anthracite, but it also contains a very considerable percentage of what is known as volatile matter, which volatile matter is composed of gases, mostly combustible, which are occluded in the fixed carbon and impurities in the coal, which occlusion may be likened to the water which may be contained in a wet sponge, or perhaps a better illustration of the meaning of this term may be had by comparing it to a liquid solution which consists of the solvent liquid which carries in solution the dissolved matter.

When bituminous coal is thrown upon a hot firebed the first thing to happen is the "distilling off" of the volatile matter which arises into the combustion chamber and is burned there as a gas while the fixed carbon remains behind upon the grate in the form of a coke where it is burned directly into carbonic acid and carbon monoxide, the same as the anthracite coal.

From what I have just said, it will be seen that not only must we provide a grate to burn our fuel but we must also provide a proper chamber above or beyond the grate in which to burn the gaseous matter which is "distilled off" from the coal. The gases composing this volatile matter are principally hydrocarbons and it is an observed fact that the hydrogen will unite with the air and burn at a lower temperature and with greater rapidity than the carbon, and if there is present only a sufficient amount of air to combine with the hydrogen and not enough to satisfy the carbon, which two gases compose the hydrocarbon gases, the hydrogen may alone be burned, the result of which combustion is a vapor of water, or more properly speaking, superheated steam, while the carbon will be thrown down in the small troublesome flocks of soot which will be carried away in the cloud of steam caused by the burning of hydrogen, and thus the color is given to the smoke.

The combustion of these hydrocarbon gases may either be suppressed or else may be made incomplete by chilling these volatile gases as they arise from the fuel bed below what is known as their ignition temperature. Every gas has a certain temperature at which it will ignite, take fire and burn, and below this temperature no combustion can take place, and again if these gases be raised to their ignition temperature, then if they be suddenly chilled below the ignition temperature, the combustion will be incomplete and smoke and waste of fuel will follow.

In order to prevent the chilling of these gases below their ignition temperature before they are completely consumed, it has been the practice in a large power plant boilers, where coal carrying a large percentage of volatile matter is used, to surround the furnace and combustion chamber with a mass of fire brick, which fire brick becomes highly heated during the process of combustion and the gases as they rise from the coal are maintained at or above their ignition temperatures and by the surrounding hot walls until the combustion is completed.

Besides these requirements, you will of course understand that it is necessary to provide means by which the oxygen contained in the air shall be brought in intimate contact with the volatile gases and thoroughly mixed with them, as if this intermixing is not properly done, there will be a large percentage of the molecules of combustible gases carried out of the furnace and unconsumed.

The above consideration gives us a general idea of the different conditions presented by the use of the two fuels, anthracite or coke on the one hand, and bituminous on the other.

Now to sum up the requirements of the general design of a house

heating boiler to handle bituminous coal satisfactorily, we must in the first place have a boiler which is designed to allow a firing at infrequent intervals, say 2 or 3 times during the 24 hours.

Second, this boiler must continue to burn this coal slowly and perfectly so as to produce no smoke.

Third, it must be designed in such a manner as to discharge its volatile gases from the furnace into a fire brick mixing chamber before these gases have time to be chilled below their critical temperature of ignition.

Fourth, this boiler must be provided with a runway in its combustion chamber of sufficient length to allow the gases to be completely consumed before they reach the chimney.

Fifth, these burning gases must be brought in contact with the heating surfaces of the boiler so as to be properly cooled to a low temperature before they are discharged into the flue outlet leading to the chimney.

Sixth, the interior of the boiler must be so designed as to have no pockets or horizontal lodging places for soot and ashes which will be carried from the fire along with the furnace gases and deposited upon or in such objectionable spots, and it is well for me to call attention at this point to the fact that a coating of soot upon the heating surface will interfere very materially with the transfer of heat to the interior of the boiler, and therefore this must not be allowed to occur to any great extent.

Seventh, the boiler should be so constructed as to not make it necessary to clean the boiler frequently.

The above requirements for a house heating boiler pertain more especially to the requirements for combustion, but aside from these requirements of course the boiler parts must be simple and not easily put out of repair, its construction and design must be such as to stand the hard usage to which heating boilers handled by incompetent boiler tenders are subjected. It should be easily manipulated as far as stoking fuel is concerned, and also as regards means for getting rid of ash and clinkers. All parts should be readily accessible for cleaning and repairs and it should be proportioned for the work to be done and capable of working to its fullest capacity with the highest economy.

There are other minor conditions which might be mentioned, but I will not attempt to continue this list further, as I believe I have pointed out the principal requirements.

Now that I have named the necessary features which must be found in a house heating boiler to handle bituminous coal satisfactorily, you will probably ask in what way can a boiler be designed to meet such requirements; and in order to anticipate this question I will describe the best form of boiler I know of to comply with the conditions I have given, and this description I believe will show that a successful and economical boiler for using bituminous coal is not only within the range of possibilities but it will point to the proper direction in which we must look in order to solve this mighty question which is pressing upon us harder and harder every year.

I have drawn a simple form of boiler which consists of two vessels, the outer one a small cylindrical water leg inside of which is contained a fire grate. The second vessel composing this boiler might be compared to a homely object found in almost every kitchen, i. e., a double boiler turned upside down, and this internal vessel is constructed of a cylindrical leg dropped down toward the fire box and having a water space provided above its crown sheet which is not at all unlike the vertical tubular steam boiler, minus the tubes, with which you are doubtless familiar. When this boiler is to be used as a steam boiler the upper part of this internal vessel is used as a steam chamber with the water found beneath the body of steam covering the crown sheet, but when the boiler is used as a hot water

boiler, of course the steam space is not required. The inside and outside vessel is connected with piping in such a manner as to allow perfect circulation of water to pass from one to the other and through these circulating pipes any steam that may be formed below the water line is easily passed into the steam space in the upper part of the central vessel. Proper provisions are also made for blowing off deposits that may form in the lower part of the water legs and simplicity in construction is found throughout the entire structure.

Now, to turn to the manner of operation, we will find that after a fire is started upon the grates sufficient coal is charged through the fire door, which is located at the upper part of the internal water leg, and as this coal is constantly surrounded by water on all sides its temperature is kept down below its point of ignition so that it will not burn until it is delivered below the water leg. As the fire burns upon the grate beneath this magazine the coal wastes away and gradually drops so as to supply sufficient fuel to the grate.

As this sufficient fuel comes in contact with the heated fire bed, its volatile gases are given off and allowed to rise between the inner and outer water leg until they reach the fire brick chamber which entirely surrounds the outer surface of this boiler with a concentric space. In this concentric space will be found a combustion chamber built in accordance with the requirements I have named above in order to prevent the burning gases from rushing directly from their point of discharge over the water legs down to the flue, cast iron baffles are placed around the boiler in the combustion chamber so as to make the gases travel comparatively three times around the boiler before finally escaping into the flue outlet to the chimney. The rate of combustion in this boiler can be controlled by an automatic regulator attached to the ash pit door of this boiler similar to those found with anthracite boilers, and tests have been made with this boiler using Southern Illinois coal which runs as high as 40 per cent. of volatile matter and with this coal the boiler has performed its function most satisfactorily and without delivering an objectionable amount of smoke.

The Circulation of Hot Water

By Albert A. Cary

The principle governing the circulation of water in heating systems is comparatively simple from a hydraulic standpoint and it can be easily illustrated by taking a simple U tube, such as I have shown in Fig. 1, having the top of the two legs opening into a common chamber or vessel.

When this simple apparatus is in use, Leg B will contain the ascending current of hot water representing the supply pipe of our system. As this water leaves the boiler, and after entering the expansion tank, which is represented by vessel A, it descends along the leg C (which represents the return piping) and passes to the boiler. When this circulating water is again heated in the boiler, the water will, of course, pass up along the line of the supply pipe represented by the leg B and so continue this cycle of circulation.

The reason for this action of the water in our circulating system is very simply accounted for when we remember that the column of water in the leg B is hotter than the column of water found in leg C, and therefore, the weight of the column of water in the leg B is lighter than that contained in the leg C.

Let us now, for example's sake, extend the top of the leg B so that it will rise to the height shown by the length E, while we make no change in the length of the leg C.

By again heating the water in the leg B, its weight per cubic inch is reduced so that it may rise to the top of the extension E and the heavy cold water contained in the leg C will just balance the weight of

the lighter water contained in the leg B to the top of its extension.

Under these circumstances no circulation whatever would take place in this system as the weight of the column of water in both legs, although extending to different heights, will just counterbalance one another.

In such a case the height E will represent the head or additional height of the column of water in leg B which causes the water to circulate.

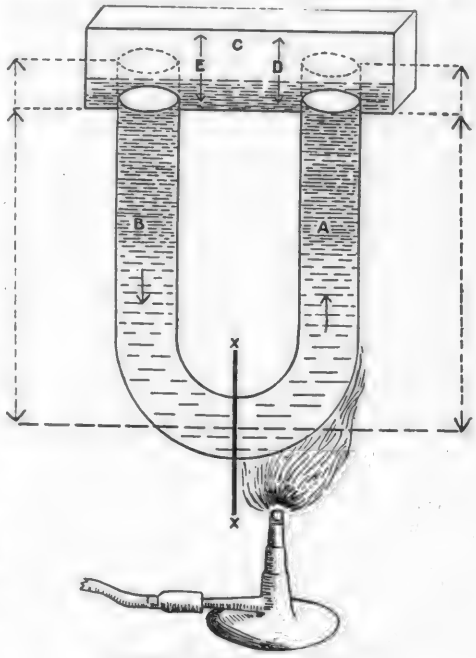
This is merely a case of water flowing from a higher to a lower level, an example with which we are all familiar, and the velocity with which this water will circulate can be computed from the formula $V = \sqrt{2gh}$. V in this formula represents the velocity of flow in feet per second while h represents the height shown by the distance E, illustrated in our drawing, while g is the acceleration of gravity or 32.2.

Unfortunately, it is impossible for water to circulate in a heating system at this velocity, owing to the friction it meets with in passing through supply and return piping as well as when passing through the boiler, and also on account of minor obstructions which I will not attempt to describe now.

In hydraulics, the height E is termed the "flow head" or the "velocity head" and in order to obtain a corresponding value which will represent the friction in the pipe, it is customary to consider this friction as equivalent to what is called a "friction head," which latter value is obtainable by calculation.

The friction in the pipe would produce identically the same effect as though we extended the height of the leg C above the line A, as is shown by the dotted line F in the drawing.

It is sometimes found in improperly installed heating systems that the friction is so great, there is no circulation whatsoever through the heating system, in which case we would show the friction head at least equal to the height E, as is shown on top of the leg C and indicated by the distance F. Under such conditions, it is easily seen that with the flow head E and friction head F extended to the same height, no circulation whatsoever will occur in our heating system, and therefore, it is very important to see that we have an ample area in our pipes and through our valves and other fittings, as well as



CIRCULATION OF WATER

through the boiler, in order to insure a perfect circulation in a heating system, and the height F should be kept as much below the height E as is practically possible to insure a perfect circulation in our hot water heating system.

There is a little puzzle in the middle of the article of the discovery of the usefulness of anthracite coal, printed in our December number. Judge Fell writes that he used the anthracite to make nails and found it profitable because he could get as many pounds of nails as he used pounds of wrought iron in making them, "and frequently a balance over." The Judge seems to state that his iron increased in weight by being exposed to the action of the anthracite fuel.

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WITH the approach of spring we may look forward to a renewal of the discussion regarding the ventilation of the New York Subway, such as followed its opening last fall. Indeed, from present indications, the subject might easily provoke a tilt among engineers that would be worth going far to see. Already we hear of the deadly gases which are now hugging the roadbed, awaiting the first warm spell to arise and smite the lungs of the unwary traveler; while, on the other hand, comes the declaration that the fear is but a bogey, destined to disappear with the expected diffusion of the gases into thin air. There is no doubt that conditions in New York city's big tunnel are radically different from those in other subways, owing largely to its proximity to the surface, and, therefore, no rules can be found that will wholly fit the case. There is a widespread popular belief that this very proximity to the outside air is an ample safeguard against all danger caused by the accumulation of gases. Yet it will not greatly surprise the engineering world if some system of circulation other than that now afforded will be found both expedient and necessary.

IF THIS should prove the case, it will present a knotty problem in mechanical ventilation that will enlist the best efforts of a large part of the engineering fraternity. Any scheme must necessarily be an extensive one and both on account of its complications and the outlay involved in its construction it would challenge comparison with the best-known types of mechanical ventilation both in this country and abroad. That ventilating engineers are fully aware of the possible opportunity that lies before them has already been shown by the tentative designs published upon the subject.

FORTUNATELY there are no locomotives in New York's Subway. If there were, we might have the prospect before us of seeing a plan carried out similar to that of Mr. Albert A. Cary for the ventilation of the New York Central Railroad's Park avenue tunnel. This scheme, which Mr. Cary recounted to the heating and ventilating engineers at their last meeting, and which is presented in this issue, involves the construction of forty 100-foot chimneys along the line of the Park avenue tunnel at distances of 250 feet apart. Inasmuch as the original plans for New York's Subway, as outlined back in the '50's, called for the use of steam locomotives, it may be left to the imagination what appearance lower Broadway would present with ventilating ducts rising from the street high

enough to clear the modern skyscraper.

AS a matter of fact, so far as we know, the originators of New York's first proposed subway made no adequate provision for its ventilation. This may or may not be the reason why the Rapid Transit engineers of the present subway dismissed the question of the extraction of gases from the tunnel when they planned to supplant electricity for steam as the motive power. Although this greatly simplified matters, the opinion remains among many ventilating engineers that the question has not been settled, by a jugful.

ACCURATE tests in the study of scientific subjects, though often a laborious and difficult method of achieving the results desired, yet, as a rule, amply repay the effort expended in securing them. The recent tests in connection with hot blast heating coils, conducted by Messrs. L. S. Poage and D. C. Thomas, under the direction of Prof. G. W. Bissell, at the Iowa State College, are no exception to the rule. On the contrary, as a prominent engineer says of them, "these tests seem to be unusually well made and the results contain more valuable information—although it is hidden away—than any set of tests of which I know." The full account of the tests is to be found in this issue.

MANUFACTURERS of heating and ventilating material who have read glowing accounts of the business boom scheduled for this year are inclined to take the prophecy with a larger or smaller grain of salt. Not only has past experience bred in them a degree of caution, but the present conditions in the market do not wholly bear out the predictions so freely made at the beginning of the year. Stock is not moving as rapidly as might be expected, although in theory there would seem to be no good reason why it should not.

The fact is that the trade, especially in the East, has had its eyes glued for some time on the calendar for May. In spite of the fact that in many cities there will be no dealings this year with labor as a body, the fateful "May agreements" still loom up, large and formidable, and the mere contemplation of them seems to create a screen beyond which no one cares to look too far.

AS we go to press we learn that the ventilating bill, introduced in the Pennsylvania Legislature at the instance of members of the American Society of Heating and Ventilating Engineers, came up for second reading in the House, March 28 last, and had its final reading the next day. Although the proposed measure does not embody all the desirable features of the Massachusetts and New York statutes, it marks a step in the right direction and should become law.

THE annual discussion as to the part a general contractor should have in the construction of buildings by the state of New York, its counties or cities, has been resumed at Albany. This year two bills have been introduced for the regulation of the letting of public work contracts, one by the State Master Steam Fitters' Association and the other by the State Master Plumbers' Association. Aside from the fact that the master fitters' bill relates only to power work, heating and ventilating,

while the master plumbers' bill relates also to plumbing, gas fitting and electrical work, the two bills differ only in details. Owing to the fact that they were introduced so late in the session, their chances of being acted on favorably are, unfortunately, somewhat remote.

THE provisions of the two bills are worth noting, however, as both of the measures are good ones and, either in their present form or with some amendments, will, no doubt, in the course of time become law. The master fitters' bill provides that specifications and the awarding of contracts for power work, heating and ventilating for all buildings for the state, county or city must be prepared and made separate and apart from the specifications and contracts for the other branches of work. There is no objection, however, to the power, heating and ventilating work, or any two of these branches being united and awarded in a single contract. The master plumbers' bill has inserted in it the words "alterations and repairs" exceeding $1,000 as constituting work that should be let separately.

IN our February paper we had something to say about the general contractor and the effect which he has upon the work of the heating and ventilating engineer and contractor.

We referred to the natural tendency of those special specialists to do all in their power to see that the owner of the building would get a job fully up to the best modern standards.

We also referred to the other natural tendency of the general contractor to get the work done as cheaply as possible, and to argue with his client in behalf of a better and more expensive job; simply to try to talk him out of some money which is already practically in his pocket, and the giving up of which yields him no benefit.

The Trade Press as a Constructive and Elevating Influence

It follows logically that if a trade paper is to exert a constructive and elevating influence in an industry, it must take a stand for certain principles, and for that reason it becomes evident at once that it cannot do so without arousing antagonism on the part of those who would see an industry destroyed to-morrow, if thereby they would secure some profit for themselves, men whose general business attitude is like that of the French king, who exclaimed, "After me, the deluge may come."

It should also be clear that for a paper to exert such a beneficial influence, it will be impossible for it to adopt a colorless policy; to be afraid to criticize that which it knows and believes to be harmful, or to be fearful of taking any decided stand, lest the interests of some advertiser be jeopardized, and thus the business interests of the paper suffer. If all the members of the trade, whether manufacturers or dealers, were willing to confine themselves to something like the truth in the claims they make for the goods they handle; and if they were willing, at all times, to do business upon reputable lines, and if they would never countenance the obtaining of the goods of a competitor by surreptitious means in order to advertise them below wholesale cost, a great deal of the existing trouble in the trade would be avoided and the life of the trade paper editor would be much easier and more comfortable than it is to-day.

A constructive and elevating policy, therefore, involves a certain amount of aggressiveness on the part of a trade editor, and forces him from the very condition of things in the trade itself to a position of direct antagonism to all that is meretricious, wrong and liable to degrade the industry and thereby affect its prosperity and standing. A trade paper which from year's end to year's end would never find anything to criticize, or never find anything which called for condemnation, could not fairly claim that its purpose was constructive and elevating. If you wish to construct, if you wish to elevate, you must clear the ground; you must exercise constant vigilance, and above all you must free healthful life from the noxious

growths that always endeavor to live on it and crush it.

The trade editor's policy, therefore, to commend itself to business men, must not only uphold what is good and meritorious, but it must strenuously and persistently oppose every effort to degrade an industry to the clap-trap, commercial level, where there is room only for those who have no self-respect, no regard for anything that is higher than the mere dollar, who believe that to ruin a competitor is one of the highest things to be aimed at, and that everything is legitimate, so long as a cheap article can be sold at a high price, and the public exploited, if not robbed.—*John C. Freund.*

New Way to Solicit Advertising

The International Union of Steam Engineers, says *American Industries*, is making a bold attempt, by threat of boycott, to get the manufacturers of the country to place their advertisements in the columns of the *International Steam Engineer*, the organ of the union, and it is soon to be seen whether this will drive them into the paper. All over the country they have received the following communication from John E. Bruner, the "General President" of the organization, which, by the way, is allied with the Federation of Labor:

Gentlemen: The International Union of Steam Engineers during the past year has established business relations with a large number of manufacturers and dealers in steam and electrical machinery and supplies to their decided advantage.

Our reason for this is because to-day our members control the purchase of more machinery and supplies than any body of men in the known world, as may be seen by the following classification of our membership:

11,000 chief engineers having purchasing power, such as chiefs of large manufacturing plants in cities and towns, street railway systems, central lighting stations, also chief engineers of nearly every municipal plant, large office building, hotel, etc., in all large cities, and chiefs practically of every brewery in United States.

13,000 engineers having recommending power, such as the engineers of plants employing a purchasing agent and those on plants where the proprietor does the buying.

11,000 men generally interested in engineering.

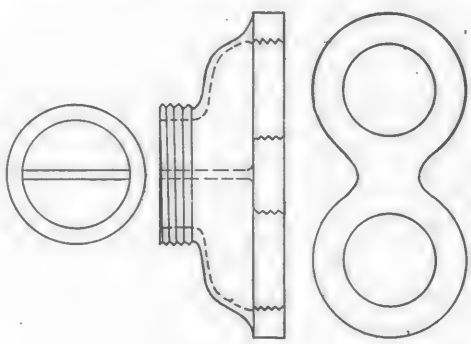
The International Convention held at Wheeling, W. Va., September 12 to 20, 1903, unanimously passed the following resolution:

Resolved, That we demonstrate to the world our belief in the great principles of unionism, of assisting those who are willing to assist us, by every member hereafter confining his purchases and recommendations (where prices, efficiency and deliveries are equal) exclusively to those whose friendship for the organization is shown by having their names appear monthly in the official "Of Whom to Buy" index published in the International Steam Engineer, our official journal.

We note on going over the above mentioned index that the name of your company does not appear therein, and thinking it a matter which may interest you, we shall be glad to furnish you with any information you may desire on the subject on receipt of the enclosed.

Single Connections for Hot Water Radiators

In the discussion of the circulation of hot water at the recent meeting of the American Society of Heating and Ventilating Engineers, Mr. William M. Mackay described an ingenious arrangement he had devised by which he proved that in the circulation of hot water through a radiator it does not make any difference whether the flow of water be taken in at the top and out at the bottom, on the same ends, or on opposite ends. He showed that if conditions were such that



connections could not be made at the opposite end, one could put two connections on one end of an ordinary radiator and secure satisfactory results.

"I have made up a special fitting," he said (shown herewith), "which I screw into an ordinary radiator, putting an ornamental plug in the opposite end, which makes the connection slightly larger, as large as 1½ inches at times. Naturally, I do not get a full area, but I find I obtain equal results as with opposite ends, and it does not short circuit. It has a division, but this is not a necessity. It lies flat, so the flow and the return go in and come out on the same level. I find there is not any difference with the same radiator, whether connected at the top or at the bottom."

TRADE AND MISCELLANEOUS NOTES

FREDERICK O. ROBINSON, treasurer of the Magee Furnace Co., Boston, died February 1. Mr. Robinson was 63 years old and had been connected with the Magee Furnace Company for twenty-nine years. He was for years the purchasing agent of the company. He was made treasurer last year.

THOMAS HOEY, president of the Thomas Hoey Supply & Manufacturing Company, Boston, died February 7.

JAMES BARRETT, of the James Barrett Manufacturing Company, Boston, is dead.

Trade Literature

THE VALVE WORLD is the title of a new publication issued by the Crane Company, which is devoted to the interest of valves and more particularly those of the publishers. It is a neat and well printed pamphlet, and as a supplement to its extensive advertising campaign will doubtless prove of value to the trade at large.

Business Changes and Announcements

WILLIAM J. McGUIRE, Mamaroneck, N. Y., has opened a steam and hot water heating and plumbing establishment at that place.

MINERAL WELLS LIGHT, POWER & HEATING Co., Mineral Wells, Tex., has been incorporated with a capital stock of $50,000.

AMERICAN RADIATOR CO., Chicago, announces that its Washington branch has been discontinued, and a branch office opened in Baltimore, at 109 East Lombard street. Its office in Buffalo is now located at Court and Franklin streets, and its Minneapolis branch at 204-206 Fourth street, South.

JAMES MERRITT & CO. have secured the services of E. J. Watson, formerly connected with the Smith & Anthony Co., Boston.

BLAKE & ANDROS, Boston, announce the appointment of A. E. Dart as their New York City representative.

UNITED STATES HEATER CO., Detroit, will have W. J. Tucker to represent them in the southern states. Mr. Tucker has been associated with the Philip Carey Manufacturing Company for several years, having charge of their office in Atlanta, Ga. He will continue to make his headquarters in that city.

RAPID HEATER CO., LTD., Grand Rapids, Mich., re-elected the following officers at their annual meeting: President, Charles H. Berkey; secretary, W. J. Loomis; treasurer, N. W. Mather.

H. W. JOHNS-MANVILLE CO., New York, elected the following officers at their recent annual meeting: J. G. Cannon, chairman o fthe board of directors; T. F. Manville, president; C. B. Manville, vice-president; Charles Hathaway, vice-president; G. W. Gladwin, vice-president and treasurer; H. E. Manville, secretary. In addition to the officers the following constitutes the board of directors: H. W. Johns, William H. Porter and C. R. Manville.

J. L. MOTT IRON WORKS, New York, will be represented in New England by Thomas F. Guion, formerly of the Niagara Radiator Co., with headquarters at 378 Boylston street, Boston.

STAPLES VALVE CO., Newburgh, N. Y., announce these officers for the ensuing year: President, John A. Staples; vice-president, C. H. Hanford; secretary and treasurer, H. B. Odell.

F. H. PUND has been elected vice-president of the recently incorporated D. T. Williams Valve Company, Mr. Pund was formerly connected with the Queen City Supply Company, of Cincinnati, Ohio.

THOMAS DEVLIN MANUFACTURING CO., Philadelphia, are building a new machine shop and warehouse at its Burlington, N. J., plant. The main building is to measure 432x52 feet.

RICHARDSON & BOYNTON CO., New York, have secured M. B. Moore, formerly of the Pennington Foundry & Heater Co., to represent them in Pennsylvania.

LORD & BURNHAM COMPANY, Irvington, N. Y., announces the appointment of John J. Foster as its New England representative, with headquarters at 112 High street, Boston. Mr. Foster was formerly connected with the Smith & Anthony Company.

KINNEAR PRESSED RADIATOR COMPANY, recently incorporated with a capital of $400,000, to succeed the Kinnear-Hood Steel Company, will have its plant at West Pittsburg, Penn. The company expects to turn out 8,000 square feet of radiation per day. W. R. Kinnear remains president and general manager of the firm.

LOTT-BURNHAM COMPANY, Chicago, Ill., succeeded, on March 1, to the business of James D. Lott & Co., 86 Lake street, and Brown & Burnham, of the same address. The new company will also control the manufacture and sale of Brown's Rival water heaters. The capitalization is placed at $20,000, and the incorporators are James D. Lott, Robert P. Burton and George D. Hoffman.

CHAMPAN VALVE MANUFACTURING COMPANY, Indian Orchard, Mass., announces the following changes, which were made at the recent annual meeting of the stockholders: Superintendent C. J. Winther retires from the board of directors and is succeeded by George B. Holbrook. Edwin McElwain fills the vacancy on the board caused by the death of Julius H. Appleton. The following officers serve for the ensuing year: President, James D. Safford; clerk and treasurer, H. R. Dalton, Jr.

CANTON HEATING & PLUMBING COMPANY, Canton, Ohio, has been incorporated with a capital of $10,000.

KLIE PLUMBING, HEATING & ELECTRICAL COMPANY, Columbus, O., is the name of a new $25,000 corporation. The president and general manager is Charles A. Klie. The vice-president and treasurer, Albert O. Glock, was formerly of the Columbus Brass Works. Other officers are: Secretary and assistant manager, Walter Klie, and superintendent, Frank E. Shaw.

AMERICAN RADIATOR COMPANY reports a net profit of over ten per cent. on its business for the fiscal year ending January 31, 1005. This is the largest amount earned by the company in the six years of its existence, the profits being $703,930, against $701,094 in the previous banner year, 1903. The retiring directors were re-elected at the company's recent annual meeting. In order to give more time to the work of the executive committee Charles H. Hodges yields up his duties as treasurer to Charles M. Parker, now vice-chairman of the foreign advisory board. Frank Powell, of the Buffalo branch, has been made superintendent of the eastern branches.

WESTERN HEATING & VENTILATING COMPANY, Guthrie, Okla., has been incorporated with a capital stock of $200,000. The incorporators are Preston K. McMinn and Edward J. Newton, both of Chicago, where the headquarters will be located.

THATCHER FURNACE COMPANY, New York, whose sign has greeted the eyes of passers-by on Water street for fifty years, will move shortly into larger quarters at 110-116 Beekman street.

UNITED STATES HEATER COMPANY, Detroit, Mich., have secured the services of T. G. Haywood to represent them in Washington, Oregon and California. His headquarters will be at Seattle, Wash.

ABENDROTH BROTHERS, Port Chester, N. Y., are preparing to double their present capacities of their boiler department.

JAMES REYNOLDS COMPANY, Rochester, N. Y., has been incorporated with a capital of $18,000 to manufacture and deal in steam and hot water specialties.

SWEET & DOYLE VALVE COMPANY, Troy, N. Y., is the title of a firm organized to manufacture bronze and iron gate, globe and check valves. A new factory for their use is now under construction.

MR. W. K. PIERCE, the well-known and genial president and general manager of Pierce, Butler & Pierce, Syracuse, N. Y., is en route for the Far East, accompanied by Mrs. Pierce. They will visit Hawaii, the Philippines, Japan and China, returning home in the autumn.

GORTON & LIDGERWOOD CO., New York, are reconstructing their line of Gorton side feet hot water and steam boilers. They have got a new line, furnishing capacities from 300 to 4,300 feet of steam and from 500 to 7,100 feet of water.

HEALTH—COMFORT—ECONOMY
DEMAND AUTOMATIC CONTROL OF TEMPERATURE.
WE SUPPLY THE DEMAND
SEND FOR CATALOGUES
THE POWERS REGULATOR CO.
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40 DEARBORN ST. CHICAGO

The steam boilers, from 300 to 2,000 feet, are in sizes 100 feet apart; above that 150 feet, and the water boilers have a corresponding range of intervals. This enables them to get very close to the requirements of any job. The heights of these boilers will range from 66 inches to 81 inches; grate diameters from 18 to 52 inches.

Mr. Gorton is also bringing out a new grate, which combines all the excellent features of the present grate and has the advantage of being removable by drawing the entire grate and frame out through the front.

These boilers will be ready for the market in a few weeks and will undoubtedly be well received by the trade.

RELIANCE HEATER & SUPPLY CO., 541 Wood street, Pittsburg, Pa., send us their new catalogue of boilers and radiators, valves, etc. The book is a very excellent piece of work and shows a fine line of goods.

The first fourteen pages are devoted to Reliance water and steam boilers of vertical sectional type, but with some variations in construction. In capacity the line ranges from 300 feet to 11,750 feet of water and from 150 feet to 5,100 feet of steam.

Then there is a hard coal, coke and gas heater made in six sizes, ranging from 1,000 to 2,875 feet of watetr and from 600 to 1,600 feet of steam.

There is also a very complete line of tank heaters.

KELLOGG-MACKAY-CAMERON CO., Chicago, have leased, for a long term of years, the large warehouse formerly occupied by the Culbertson & Blair Packing & Provision Co., Eighteenth and Canal streets.

This building, which will be used exclusively for stock and ready for occupancy about April 1, is one of the best located warehouses in the city. The Pennsylvania Railroad tracks are im-

The Albany Return Steam Traps

have been the **STANDARD** for over **THIRTY-TWO YEARS.** For returning water under pressure to the boiler, they will perform this duty fully as well, and in many cases better than the so-called steam loop.

Send for circulars A, B, C and D.

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FREDERICK TOWNSEND, PRESIDENT — JAMES H. BLESSING, GEN. MGR.

TO THE TRADE

The New Directory for 1905 of Master Plumbers and Master Steam and Hot Water Fitters of United States and Canada, also list of Manufacturers and Jobbers, with classified list of goods manufactured in Plumbing, Lighting and Steam Heating, including the trade names of Closets, Bath Tubs, Hot Air, Steam and Hot Water Heaters and Boilers, is now being compiled. This Directory is the need of the day and a Buyers' Reference. Subscribers can have their name in display type without extra expense. Send in your order for a copy. Price $5.00 when published. Advertising rates given on application.

Plumbing and Heating Publishing Co.

Room 6074, Metropolitan Building — NEW YORK CITY

mediately on the east side of the building and the C. B. & Q. tracks skirt the west side, so that the receiving and shipping of material is easy and direct as it is possible to make it.

The building is particularly suited to the needs of the business, and the company is reconstructing and remodeling the interior so that the stock may be kept and handled with a minimum of labor and trouble. There are four floors whose total area amounts to over 130,000 square feet. A large and complete stock will be carried at all times, so that the steam fitters' or the plumbers' wants may be supplied with ease.

The general offices of the company will be moved about January 1, 1906, to the new building at Twelfth and Michigan avenue, recently purchased by the company. This building will be occupied exclusively for office purposes and no stock will be carried in it. The first floor will be fitted up as an exhibition and sales room, where all styles of boilers, radiators, plumbing and heating fixtures will be displayed.

Contracts Awarded

MANGRUM & OTTER, San Francisco, Cal., steam heating six-story brick building. Contract price, $3,365.

HOTALING & MURPHY, Johnstown, N. Y., heating St. Patrick's Church.

M. J. DALY & SONS, Waterbury, Conn., heating and plumbing fire engine house.

WILLIAM A. POPE, Chicago, Ill., heating Graham School building on Forty-fifth street and Union avenue.

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Engraver AND Electrotyper
ILLUSTRATIONS OF HEATING SYSTEMS A SPECIALTY.
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NEW YORK

A GOOD MAXIM

"Keep your feet warm and your head coal" is the maxim for health. But with most steam heating systems this is impossible, for they keep you either hot or cold at both ends alike. The

WEBSTER SYSTEM OF STEAM CIRCULATION

is distinguished from all others by the fact that each occupant can adjust the heat in his own room to suit himself exactly. It gives health and comfort, and yet costs less to install and to operate.

Ask your consulting engineer, or send for booklet 17-H.

WARREN WEBSTER & Co.
CAMDEN, N. J.

CAMPBELL - LAIRD HEATING CO., Minneapolis, Minn., hot-water heating new residence at 312 Malcolm avenue.

SCHELL HARDWARE CO., Somerset, Pa., heating and plumbing Schafer store and apartment building.

ANDERSON-DARRAGH CO., Pittsburg, Pa., heating Toxaway Inn., at Toxaway Lake, N. C.

KORSEMEYER & CO., Lincoln, Neb., heating and plumbing new court house at Dennison, Iowa. Contract price, $9,548.

H. SWEENEY & CO., Seattle, Wash., steam heating and plumbing new Northern Pacific building. Contract price, $9,000.

CARTER, ADAMS & CO., Bangor, Me., heating Bancroft-Foote building at Good Hill Farm.

FREDERICK BEARDSLEY, Stratford, Conn., steam heating Episcopal Church.

IOWA MANUFACTURING CO., steam heating Kirksville, Mo., post office. Contract price, $1,494.

POWERS REGULATOR COMPANY, New York, has the contract for an elaborate system of ventilation and proper regulation of temperature for the New York Hippodrome, now approaching completion.

GLOBE ENGINEERING COMPANY, San Francisco, Cal., is installing a system of ventilation for the Pacific Union Club, to cost $2,500.

C. H. SWANSTROM, Seattle, Wash., is heating and plumbing the new Summit school. The contract amounts to $4,949.

J. F. JOHNSON COMPANY, Fall River, Mass., have the contract for heating and plumbing the $50,000 block for the Globe Publishing Company.

HARRY F. MURPHY & CO., Philadelphia, have secured the contract for the heating plant in the new $400,000 East Liberty passenger station of the Pennsylvania Railroad, at Pittsburg.

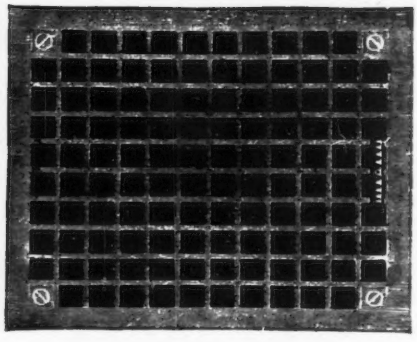
THOMAS B. YERGER, San Bernardino, Cal., has the contract for installing the hot water appliances in the Arrowhead Hot Springs bath house, to cost $5,000.

DENNY BROTHERS, Newark, N. J., have the contract for steam heating the Newark Eye and Ear Infirmary, calling for direct and indirect work.

MANSFIELD PLUMBING COMPANY, Passaic, N. J., are installing the steam heating in the new Volger factory and the new National Hotel.

W. G. McPHERSON, Portland, Ore., heating department store, including boilers for furnishing heat to a system of steam heating coils, through which fresh air is drawn and distributed through

KERNAN WELCOME REGISTERS



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Syracuse Stove Works, Syracuse, N. Y.

TELEPHONE **NEW YORK OFFICE AND WAREHOUSE** **383 JOHN**

231 WATER STREET

building by means of piping. Contract will amount to $4,000.

J. A. MONTGOMERY, Astoria, Ore., heating Hedrick Theater.

E. P. METZGER, Bakersfield, Cal., heating Hotel Metropole.

JOHN O'DONNELL, Evansville, Ind., heating Frederick Realty Co.'s new apartment building, Owensboro, Ky.

HUEY BROS., 35 Hartford street, Boston, heating by steam, a $30,000 building at the Westboro Insane Asylum.

JAMES E. DREW, 51 E. Wheeling street, Washington, Pa., heating five-story Brown block on Main street.

JOHN O'DONNELL, Evansville, Ind., heating residence of G. P. Nestor, Booneville, Ind.

J. F. CORCORAN, 198 Main street, Brockton, Mass., heating and plumbing residence.

McLACHLAN BROS., Wilkinsburg, Pa., heating by hot water, residence of Dr. Maratta.

LIBERTY SUPPLY CO., Waynesburg, Pa., heating business block on Morris street.

DRUMMOND HEATING CO., Punxsutawney, Pa., heating and plumbing residence.

B. MACKENZIE, Greenboro, N. C., heating St. Leo's hospital.

B. G. CARPENTER & CO., Wilkes-Barre, Pa., report a long list of school buildings where they are placing the Carpenter system of warming, ventilation and sanitation. Among them are the following: Two each at Jersey Shore, Shamokin, Mauch Chunk, and Sunbury, Pa., and Blairstown, N. J. One each at Montgomery, Williamsport, Duryea, Edwardsville, Old Forge and Catawissa, Pa.

ED. S. MOBLEY & BRO., Frederick, Md., installing 80 H. P. boiler at the Western Maryland College, Westminster, Md.

VAUX & CO., 257 Pearl street, Buffalo, N. Y., heating for the U. S. Government, new administration building and field officers' quarters, Fort Ontario, Oswego, N. Y., War College, at Washington, D. C., and new post office and custom house, at Hartford, Conn.

MIDGLEY BROS., Salt Lake City, Utah, heating Young Men's Christian Association building, using the Paul system.

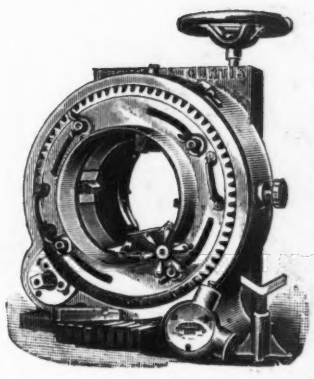
LARSON & MOORE, Longmont, Col., heating and plumbing Imperial Hotel.

A. W. MEEK, Ogden, Utah, heating and plumbing Pacific Hotel, Green River, Wyo.

FISH-BURGE PLUMBING & HEATING CO., Pueblo, Col., heating addition to St. Mary's Sanitarium.

FORBES' PATENT DIE STOCKS

Pipe Cutting and Threading Machinery For Hand or Power



Pipe up to 15 inch cut off and threaded by one man with ease

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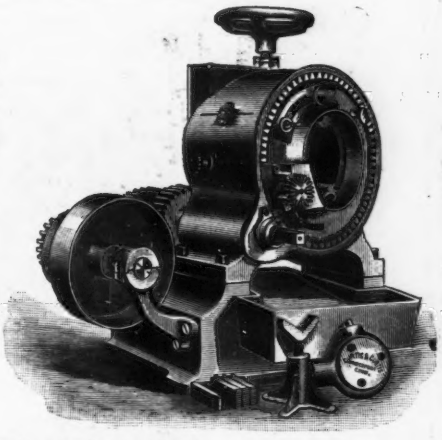

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THE CURTIS & CURTIS CO.

48 Garden Street **BRIDGEPORT, CONN.**

MATSON BROS., Brookville, Pa., heating Odd Fellows' new building, at Reynoldsville, Pa.

CALIFORNIA ENGINEERING & CONSTRUCTION CO., San Francisco, Cal., heating and ventilating seven-story building on Taylor street.

CALIFORNIA ENGINEERING & CONSTRUCTION CO., New Montgomery street, San Francisco, Cal., heating and ventilating Fairmont Hotel, Powell and California streets.

VAN DYKE & CO., Des Moines, Iowa, heating and plumbing new apartment house.

ARTHUR McGONAGLE & CO., 136 Liberty street, New York, heating factory of E. W. Bliss Co., Brooklyn.

D. J. DEADY, 105 West Ninety-seventh street, New York, heating Merles auction rooms at 155 East 125th street.

HOWLAND & PARCELLS, New Haven, Conn., heating residence for Geo. Chidsey, East Haven.

E. E. LEOHSE, New Haven, Conn., heating and plumbing new 12-room house.

L. C. SIMPSON, 820 Broadway, Camden, N. J., heating, plumbing and gas-fitting Linden Baptist Church.

SLOAN PLUMBING & HEATING CO., Pittsburg, Pa., heating and plumbing large store rooms and apartments in building at Forbes and Craig streets.

FRONTIER PLUMBING & HEATING CO., 481 Washington street, Buffalo, N. Y., heating engine house No. 1 on South Division street.

CARL LUCAS, Pekin, Ill., heating and plumbing A. Zerwehk's residence.

JOHN O'NEILL & SONS, Peoria, Ill., heating and plumbing new Proctor Home.

SPRINGFIELD PLUMBING CO., Springfield, Mo., heating and plumbing post office and court house at Harisonville, Ark.

JOHN F. JOHNSON CO., 371 Central street, Fall River, Mass., heating, plumbing and lighting new Easter avenue school building.

FRED L. ALBRECHT, 1003 Parade street, Cleveland, O., heating and plumbing combination store and apartment house at Erie, Pa.

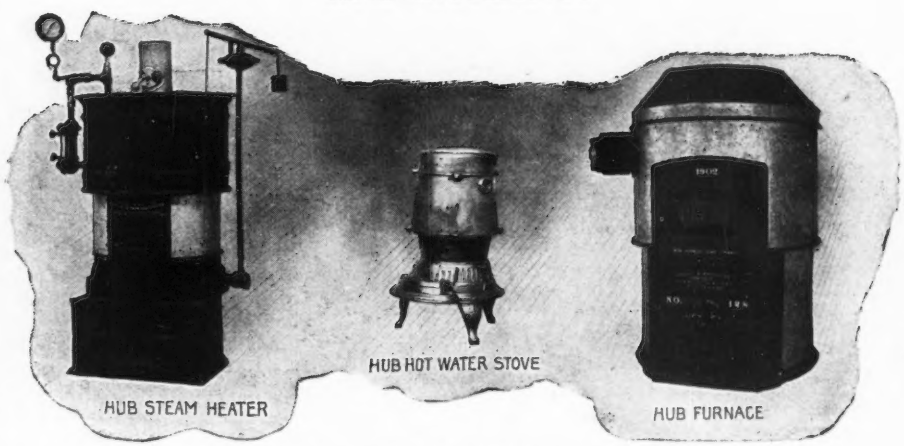
T. W. WATKINS, Portsmouth, O., heating and plumbing business block.

ANDREW McGLYNN & CO., Taunton, Mass., heating new armory.

GEORGE ADAMS & CO., Glens Falls, N. Y., heating, ventilating and plumbing new Glens Falls High School.

Hub Heating Apparatus

SUPERIOR IN DESIGN, CONSTRUCTION AND EFFICIENCY



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